

Cooperative Learning and Elaborative Interrogation:
Effects on Children's Learning

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Abstract

This experimental study examined the effects of cooperative learning and a question-answering strategy called elaborative interrogation ("Why is this fact true?") on the learning of factual information about familiar animals. Retention gains were compared across four study conditions: elaborative-interrogation-plus-cooperative learning, cooperative-learning, elaborative-interrogation, and reading-control. Sixth-grade students ($n=68$) were randomly assigned to the four conditions. All participants were given initial training and practice in cooperative learning procedures via three 45-minute sessions. After studying 36 facts about six animals, students' retention gains were measured via immediate free recall, immediate matched association, 30-day, and 60-day matched association tests. A priori comparisons were made to analyze the data. For immediate free recall and immediate matched association, significant differences were found between students in the three experimental conditions versus those in the control condition. Elaborative-interrogation and elaborative-interrogation-plus-cooperative-learning also promoted long-term retention (measured via 30-day matched association) of the material relative to repetitive reading with elaborative-interrogation promoting the most durable gains

(measured via 60-day matched association). The relationship between the types of elaborative responses and probability of subsequent retention was also examined. Even when students were unable to provide adequate answers to the why questions, learning was facilitated more so than repetitive reading. In general, generation of adequate elaborations was associated with greater probability of recall than was provision of inadequate answers. The findings of the study demonstrate that cooperative learning and the use of elaborative interrogation, both individually and collaboratively, are effective classroom procedures for facilitating children's learning of new information.

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CHAPTER ONE:INTRODUCTION

Background of the Problem

In recent years there has been a great deal of concern about whether our schools are preparing students adequately for the twenty-first century. Critics argue that educational standards of literacy and numeracy have dropped (Hirsch, 1987). In light of the increasing competition in a global market, recommendations have been made that there should be a return to the teaching of basics, more direct teaching and less "discovery approach" learning, increased use of standardized testing, and more focus on cognitive development. One underlying concern of educational reformists is that acquisition of knowledge is too often disregarded as skills and processes are emphasized through a "content-neutral" approach to learning. Hirsch (1987) and others feel that there needs to be a more integrated curriculum which incorporates a broad range of subjects and activities in order to promote "cultural literacy," a network of "basic information needed to thrive in the modern world" (p. xiii).

There has also been a recent thrust to develop a more holistic educational approach that would foster students' affective and social development as well as promote academic achievement. This mandate is articulated in the new Ontario Ministry Document "The Common Curriculum" (1993). Educators

have increasingly been asked to fulfill students' social and emotional needs which, in the past, were mainly fulfilled by traditional institutions such as the family and places of worship. With many topics such as sex education, V. I. P. (Values, Influences and Peers) and drug and alcohol awareness being added to an often fragmented curriculum, many educators feel overwhelmed as they seek to cover core information, teach learning skills and strategies, promote interpersonal skills, and foster emotional well-being.

Although considerable controversy exists about how best to prepare students for successful and productive lives in the future, research from the areas of cognitive psychology (constructivist theory of learning and explicit strategy teaching) and classroom organization (cooperative learning) has provided educators with useful guides. Insights from these disciplines have been used to instruct students in ways that allow them to gain a storehouse of valuable knowledge, develop critical thinking skills, become lifelong learners, as well as learn to communicate and work effectively with others. This study is an investigation of the use of one of the many effective strategies that both students and teachers can add to their study skill repertoires and of its application in a cooperative learning setting.

Within this century, theorists such as Vygotsky, Kohlberg, Piaget, and Dewey developed a constructivist view

of learning where individuals actively shape their knowledge through social interaction (Harris & Pressley, 1991; Stevens, Slavin, & Farnish, 1991). Constructivists believe that learning takes place when participants build on their relevant prior knowledge and experiences, integrating new facts and concepts in a meaningful and purposeful manner.

This active view of learning can be further enhanced through a social setting such as cooperative learning (Paris & Winograd, 1990; Stevens et al., 1991; Tobin & Fraser, 1991). Through discussion and teamwork, individuals restructure their ideas as information is shared, clarify opinions through articulation with others, and connect and organize new knowledge into existing schemata.

There is considerable research (Johnson & Johnson, 1991; Johnson & Johnson, 1990a, 1990b; Kagan, 1990; Lambiotte, Dansereau, Rocklin, Fletcher, Hythecker, Larson, & O'Donnell., 1987; Sharan, 1990; Slavin, 1987a, 1987b) that substantiates the effectiveness of collaboration. Studies have found that cooperative learning increases academic achievement as well as enhancing emotional health and promoting positive social skills relative to traditional competitive or individual learning. Students need frequent opportunities to collaborate with others since success in dealing with the complexities of the modern world requires the cooperation of many people with different specialities.

Merely placing students in groups will not ensure

the development of these collaborative skills. It is important to structure cooperative endeavours so that beneficial results are more likely to occur (Lambiotte et al., 1987; Stevens et al., 1991). Structure is especially important when students are learning factual material. When given little or no direction, students frequently fail to adopt an active stance or use effective strategies (Marfo & Ryan, 1990; Lambiotte et al., 1987; Wood, Pressley, & Winne, 1990). Educators who assume a constructivist view of learning need not apologize for teaching explicit strategies since:

True discovery is rare, inefficient, and time consuming; it is impossible for students to discover all that they need to know; some students may experience high levels of frustration under discovery approaches; discovery may be errorful; and only a small proportion of students may make most of the discoveries. (Harris & Pressley, 1991, p. 401)

Cognitive strategy instruction does not preclude active construction of knowledge. Rather, it enables and empowers students to learn efficiently and effectively.

Students also need to be given ample opportunities for fact acquisition in order to widen their prior knowledge base. It is difficult to develop higher level thinking skills when lower level knowledge and comprehension skills are not well-established. Although the rate of information

is rapidly expanding, individuals still require some common knowledge base in order to enhance their understanding through discussion. Specifically, if basic elements of schemata exist, they will be able to communicate more effectively and will be more likely to increase their learning.

Recently, researchers (Pressley, Wood, & Woloshyn, 1990; Woloshyn et al., in press; Woloshyn, Paivio, & Pressley, in press; Wolosyhn, Pressley, & Schneider, 1992; Woloshyn et al., 1990; Wood, Fler, & Willoughby, in press; and Wood et al., 1990) have begun to investigate how retention of new material can be enhanced through the use of a strategy called elaborative interrogation. This question-answering strategy ("Why is this fact true?") encourages learners to activate their relevant prior knowledge in order to make inferences about and elaborate new material (Woloshyn, Wood, & Willoughby, in press). There is considerable evidence demonstrating the effectiveness of this strategy relative to reading for understanding. Elaborative interrogation has worked successfully for a wide range of ages (from Grade Four students to undergraduates) and with a wide variety of topics (animal facts, Wood et al., 1990; facts about different universities, Woloshyn et al., 1990; scientific misconceptions, Woloshyn et al., in press; and facts about Canadian provinces and German states, Woloshyn et al., 1992).

At present there is no research on the effectiveness of elaborative interrogation when used in a cooperative learning setting. The primary purpose of this study is to determine whether elaborative interrogation in a cooperative learning situation promotes learning more so than either approach on its own or reading for understanding. Since students using this strategy collaboratively would be sharing information and gaining exposure to other peoples' points of view, their retention gains might be greater than those of students using elaborative interrogation on their own. Additionally, by structuring their study of the material through use of this strategy, students in the elaborative-interrogation-plus-cooperative-learning groups might process the target information in a more meaningful and purposeful manner than students in the cooperative groups. Finally, as students in all three experimental conditions might be more actively engaged in learning the new material, their retention gains might be superior to those of reading-control students. This study will also investigate the relationship between types of elaborative responses given during study and subsequent recall of target information.

Finding efficient educational interventions that assist students in becoming successful learners with strong interpersonal skills is one of the challenges facing today's educators. This study was designed with this challenge in

mind.

Definitions

Adequate Elaborations-responses that are logical

explanations of why the facts about particular animals are true.

Cooperative Learning-a set of instructional methods in which

students are encouraged or required to work together in small, heterogeneous groups towards academically as well as socially beneficial goals.

Elaborative Interrogation-a question-answering strategy

("Why is this fact true?") that encourages learners to draw upon their prior knowledge in order to make inferences and elaborations about the to-be-learned material.

Elaborative Interrogation Plus Cooperative Learning-a

small group setting where heterogeneous members share their available prior knowledge and collaboratively elaborate on the new material by answering why questions.

Inaccurate Elaborations-adequate responses that

offer logical explanations but which are not based on relevant scientific information about the animals.

Inadequate Explanations-"pat" answers that do not make clear

why the given facts about the animals are true.

Incorrect Statements-errors which are made during recall

about the presented animals.

Intrusion Errors-facts which are presented during study

but are recalled in response to the wrong animal.

Irrelevant Statements-facts that are correctly recalled

about the animal but which are not part of the

targetted information.

No Responses-failures to generate any reasons why the

given facts are true.

Scientifically Correct Elaborations-adequate responses

that are consistent with true facts about the animals.

Supporting Elaborations-generation of another adequate

elaboration given by a member in an elaborative-

interrogation-plus-cooperative-learning group in

support of a teammate's logical response.

CHAPTER TWO: REVIEW OF THE LITERATURE

Overview of the Chapter

In this chapter, the changing purposes of education needed in an informational society are first explored. Theoretical perspectives (constructivism and scaffolding) on cognitive development that have influenced new initiatives in education (active learning and cooperative learning) are then discussed. The section on cooperative learning contains research findings as well as details on the characteristics, models, implementation, and benefits of this technique. Research findings on elaborative-interrogation strategy use learning are next presented. At the conclusion of the review of the literature, the purposes of the present study and the hypotheses are outlined.

Changing Purposes of Education

One of the primary goals of education has always been to prepare individuals for productive participation in the societies in which they live. Traditionally, schools have focused on academic learning and preparing students for entry into the workforce. But education should also sustain our natural curiosity to seek the inter-relationships between the historical, social, psychological, natural, and spiritual dimensions of our lives. More recently, there has been a shift towards developing a more holistic, learner-centred approach to education, one that includes the

affective sphere as well as the cognitive domain (Combs, 1981, Furner, 1984, Nash, 1980, cited in Benjamin, 1989). Cooperative learning is one method which effectively enhances the cognitive and interpersonal skills needed to meet the challenges of the twenty-first century.

The concept that education should be directed towards helping individuals reach self-actualization is reflected in the Ontario government policy "The Formative Years," which is also known as "Education in the Primary and Junior Division" (1975). While respecting the individual needs and differences of each child, educational experiences should provide opportunities for students to both individually and cooperatively:

acquire the basic skills fundamental to his or her continuing education; develop and maintain confidence and a sense of self-worth; gain the knowledge and acquire the attitudes that he or she needs for active participation in Canadian society; and develop the moral and aesthetic sensitivity necessary for a complete and responsible life. (pp. 6-7)

In our rapidly changing society, which, in the past, has moved from an agricultural base to an industrial base, and now is moving from a technological base to an informational one, there is an even greater need for the development of skills and strategies that will enable and empower individuals to effectively deal with their life

experiences. Since it is difficult to anticipate the direction and rate of change of the future, a prime objective of education should be to increase an individual's "cope-ability" by increasing critical judgement-making ability and flexibility (Toffler, 1971). Benjamin (1989) stresses that students must be taught how to anticipate, understand, and cope with change and global interdependence. With the rate of technology and new information in our "global village" increasing ever rapidly, education must help individuals learn how to pool their talents and resources, work collaboratively, and learn how to become lifelong learners.

Theoretical Perspectives Towards Learning

In addition to the changing demands of society, the theories underlying the processes of cognitive development have also undergone change. In the past, it was assumed that children acquired knowledge through a process of transmission in which facts were accumulated through what Green and Myers (1990) term a "gulp and regurgitate" method. Students were viewed as "tabulae rasae" and teachers were seen as the expert dispensers of knowledge. It was believed that students would acquire facts, concepts, and skills through a passive process of rote memorization and repetitive practice. Since the emphasis was on retention and product rather than the process of learning, good

students were viewed as those who could recite and produce the material they had learned verbatim. Little consideration was given to students' prior knowledge, experiences, perspectives, and individual styles of learning. Students were expected to work on their own in an independent and competitive learning environment.

Constructivist Theories

Lately, the area of cognitive psychology has provided educators with a more active and social concept of learning where individuals construct their own knowledge through interpersonal relationships. Noddings (1987), Novak (1988), Paris and Winograd (1990), Harris and Pressley (1991), and others believe that this constructivist theory of learning should underlie educational practices. Constructivist theorists believe that knowledge is continuously being shaped and produced by individuals and groups as they reflect and act upon their experiences. Through discussion, individuals discover new information and try to understand old information from new perspectives. Cognitive change results when conflicting ideas are resolved.

Many of the underlying principles of the constructivist theory have been influenced by the works of Dewey, Vygotsky, Piaget, Kelly, and Kohlberg (Harris & Pressley, 1991; Paris & Winograd, 1990). For instance, Dewey (1963) believed that students should be actively involved in decision-making,

drawing conclusions, and forming attitudes through educational activities based on personal experiences and interactions with others. Critical thinking, intellectual experimentation, psychological freedom to test judgements in action, and reflection were also emphasized in Dewey's writings.

Vygotsky believed that children develop higher order thinking skills by first being exposed to them in interpersonal situations. Cognitive conflict is facilitated through the social exchange of shared information. Understanding is promoted through active learning as individuals build on their prior knowledge and seek to transform old knowledge into new knowledge. Students' problem-solving ability is enhanced in collaboration with peers and under adult guidance.

Scaffolding

Another aspect of Vygotskian theory is that instruction is best when it is within the "zone of proximal learning," the area between independent level (mastery) and instructional level (developmental). Scaffolding of instruction and support should be provided in a flexible manner with an emphasis on increased independence as mastery is attained. Specifically, considerable guidance and direction should be provided by teachers when concepts and skills are being introduced and then gradually decreased as

students become more competent.

Further descriptions of the role that scaffolding plays in the process of developmental learning are provided by Patterson and Hundey (1990), Forrestal (1990), and Green and Reid (1990). The degree of support varies according to learners' needs as they move through different stages in a dynamic, cyclical manner. Green and Reid identify these stages as: 1) engagement, where a particular activity is linked to a wider knowledge base and the reasons why this area is being studied are elicited; 2) exploration, the provision of a flexible time period of investigation where students can make personal connections to their prior knowledge; 3) transformation, when the students reorganize the information for a specific purpose and audience; 4) presentation, where the new knowledge is communicated and feedback is provided; and 5) reflection, where the learning experience is evaluated individually and collaboratively. Throughout this process, the teacher acts as a facilitator and co-learner working with the students towards common goals and focussing their mental processing.

New Initiatives in Education

Active, Negotiated Learning

The theoretical and philosophical changes in education have not gone entirely unnoticed in classroom practices.

The Peel Board of Education is one of many school boards trying to implement the recommendations outlined in the Ontario Ministry document "Active Learning" (1989). Students are encouraged to participate more fully in all aspects of their educational activities and to assume more responsibility for their own learning. As Boomer (1990) shows, this can be done through a collaborative model of negotiated learning where teachers and students work together as co-learners to negotiate and plan an area of study, set flexible aims and objectives, explore the topic, and collectively reflect and evaluate cognitive processes, strategies, and achievements. By encouraging personal commitment, and by building on students' interests, teachers can facilitate high quality learning. Students are encouraged to make connections between new concepts and their prior knowledge, to rigorously explore new areas, and to organize and communicate their shared discoveries in meaningful ways. In this manner, new knowledge is actively and purposefully incorporated into each student's personal construct. Retention is facilitated by the depth of processing and organizational strategies involved in this active learning model.

Cooperative Learning

Characteristics of cooperative learning.

In keeping with the active, social view of learning, there has been an increasing interest in the study of collaborative learning. Sharan (1990) states that there is strong empirical evidence from two decades of research on the effectiveness of cooperative learning. Tobin and Fraser (1991) believe that interaction with others is critical for students to make sense of what they are learning. As new information and different points of view are shared in discussion, students change their mental organizations as they attempt to integrate various facts and concepts. Cooperative learning provides opportunities for learners to negotiate meanings with others as they effectively develop cognitive and verbal strategies and social skills.

Although many classrooms typically use groups for instructional activities, true cooperative learning involves more than simply putting the students into groups. It entails structuring the learning environment so that students work together in small groups directing their efforts towards achieving common academic and social goals (Bohlmeyer & Burke, 1987; Johnson & Johnson, 1990a; Nastasi & Clements, 1991; Watson, 1991).

In order to maximize learning by all participants, Johnson and Johnson (1991; 1990a; 1990b; cited in Guskey,

1990) believe that cooperative learning opportunities must be structured to incorporate five essential components: positive interdependence, face-to-face positive interaction, individual accountability, interpersonal and small-group skills, and group processing (reflection). Kagan (1990) and Nastasi and Clements (1991) also endorse these basic features. Teachers can promote successful interactions through the inclusion of these components in the learning environment.

Positive interdependence entails the belief that all members are linked together as they work towards a common goal such as a completion of a project or worksheet or the production of a play. They can succeed only if each individual of the group reaches the goal, ("If you do well, I do well") (Nastasi & Clements, 1991). This perception encourages a more dominant or capable student to accept and value the unique contributions from the other members of the group.

Through face-to-face positive interaction, members support one another in their cognitive and interpersonal activities. Students endeavour to understand and build on the viewpoints of others through the sharing of knowledge. Through discussion and explanation, connections are made between past and present learning. Opportunities are provided for positive modelling of appropriate social and academic behaviours. Constructive criticism instead of

"put-downs" is encouraged.

Some educators feel that weaker or less motivated students might allow other members of the cooperative group to take over, leaving them to have "a free ride."

Individual accountability eliminates this problem (Johnson & Johnson, 1991, 1990a, 1990b; Nastasi & Clements, 1991). The performance of each member is assessed and each individual is ultimately responsible for his or her own learning.

Feedback is given both to the individual and to the group so that additional support, assistance, and encouragement can be provided as needed.

Johnson and Johnson (1991, 1990a, 1990b), Kagan (1990), and Nastasi and Clements (1991) believe that interpersonal and small-group skills must be taught, modelled, and practised in order for high quality collaboration to occur. Some of these social skills include leadership, decision-making, trust-building, communication, and conflict-management skills. Teachers may initially wish to focus on developing these skills through specific lessons, role-playing, and games or they may encourage positive interrelationships and skills as their students engage in more academic pursuits.

The fifth component of collaborative learning is the ongoing process of reflection. Students and the teacher discuss how well they are maintaining effective relationships using their social skills, and how well they

are achieving their goals. Members are encouraged to practise collaborative skills consistently. In one study investigating the impact of reflection on achievement in cooperative learning groups, Yager, Johnson, Johnson, and Snider (1986) found that Grade Three students who engaged in reflection achieved higher daily achievement scores and post-instructional achievement scores than did students in a cooperative learning group without reflection and students in an individual-study condition.

Taylor (1989), Noddings (1989), Nastasi and Clements (1991), and Johnson and Johnson (cited in Bohlmeier & Burke, 1987) claim that group rewards can be an optional feature of cooperative learning. They admit that there is some controversy in the literature over the use of competition between groups. Noddings believes that steady competition between teams is unlikely to promote cross-ethnic friendships, sharing, and empathy as claimed by Slavin (1987a; 1987b; as cited in Mesch, Johnson, & Johnson, 1988) and others. Johnson and Johnson also believe that serious competition will lead to negative interpersonal relationships. They state that achievement is improved through the positive interaction that occurs when students believe that they can achieve their goals only if the other members of their cooperative group attain these goals. Since Slavin (1987a; 1987b; as cited in Mesch et al., 1988) claims that students in cooperative groups will increase

their achievement only if they are motivated by a group reward, a study was undertaken by Mesch et al. (1988) to compare the effects of positive reward interdependence (members are rewarded when goals are attained) to positive goal interdependence (members work towards common goals) on achievement. The results indicated that positive goal interdependence did increase achievement of Grade Ten students in social studies as compared to individual efforts, however "both positive goal and reward interdependence are needed to maximize student achievement" (Mesch et al., 1988, p. 345). Therefore, if the emphasis is on increasing student achievement, incorporating two ways of structuring positive interdependence appears to be more effective.

Models of cooperative learning.

Enabling students to develop the skills involved in the five components of cooperative learning is no easy task. Johnson and Johnson (1990a; 1990b; cited in Hill & Hill, 1990) believe that it can take from one to two years before these skills are second nature, depending on the amount of previous experience that students have had in cooperative learning and on their age and maturity. Any teacher wishing to implement cooperative learning in the classroom will need empathy, patience, knowledge, and skills. As there are several models of cooperative learning to choose from,

Bohlmeyer and Burke (1987) recommend that a teacher become familiar with the basic elements of each model, and then select one that is compatible with their style of teaching and their specific instructional objectives. Each of the cooperative models briefly described in the following section has been empirically shown to be beneficial in promoting active, holistic learning.

The group-investigation model of cooperative learning, which is sometimes referred to as small-group teaching, was developed by Sharan and Sharan in 1976 and refined by Sharan and Hertz-Lazarowitz in 1980. This procedure allows students to collaboratively plan and carry out an investigation, synthesize and summarize their findings, and present a final report to share with the class. This method is generally used in the areas of social studies, science, history, and geography where general units of study are broken down into subtopics. The students form small, heterogeneous groups to investigate a subtopic that interests them and then present their discoveries to their classmates. On-going reflection and evaluation are stressed. Bohlmeyer and Burke (1987), Nastasi and Clements (1991), and Sharan (1990) state that students who use group-investigation demonstrate better conceptual understanding of the material covered, attain a higher level of school achievement, are more altruistic, are more cooperative in social interactions, and demonstrate a more positive

attitude towards school as compared to students in a traditional setting.

Kagan (1990; cited in Bohlmeier & Burke, 1987) describes several cooperative learning techniques that he has developed. One approach, co-op co-op, is similar to group-investigation but is implemented in a more structured manner using ten different steps. After an initial class discussion about the general topic of investigation, team-building activities are used to develop cooperative skills before academic tasks are undertaken. Sub-topics are then investigated in small groups by having individual members research mini-topics. Information is integrated from the findings of each member in order to prepare a group project for presentation to the class. Students are responsible for learning all material presented by all the groups. A flexible method of evaluation of both individual and group efforts is recommended. Individual contributions to the team as well as individual papers and projects should be considered. The co-op co-op approach has been found to have favourable social and academic effects for both high-school and college students.

In the expert-group approach to cooperative learning, each member of the group is responsible for teaching material to the other members. In the Jigsaw method, developed by Aronson and his colleagues (1978, 1980, cited in Bohlmeier & Burke, 1987), each member of a heterogeneous

home group is required to thoroughly learn some aspect of a topic or assignment. They then meet with students from different groups who have studied the same material in order to discuss their findings, clarify their understandings, and plan how to present the material to the other members of their home groups. Next, the students reconvene in their home groups, share their different areas of expertise, and are assessed on an individual basis. Cooperative skills are taught directly and encouragement is given for students to reflect on their group processes.

In the Jigsaw II method, designed by Slavin (1985a, 1986, cited in Nastasi & Clements, 1991), the students also meet in expert groups to learn material related to specific topic areas and then reconvene in their home groups to teach this material to the other members. The major differences between Jigsaw and Jigsaw II are that in the latter approach, information is gathered and learned from resource materials rather than from information provided by the teacher; students read all the material on a unit of study but develop expertise in only one specific subtopic; and, students are evaluated and rewarded on the basis of both individual and group performance. Both of the expert-group methods improve cross-ethnic attitudes and behaviours, although Slavin (1985, cited Nastasi & Clements, 1991) states that greater effects on students' achievements have been found through use of Jigsaw II.

Slavin has also developed other methods of cooperative learning which are collectively known as Student Team Learning. Examples include Student Teams-Achievement Divisions (STAD), Teams-Games-Tournaments (TGT), and Team-Assisted Individualization (TAI). Bohlmeier and Burke (1987) have also classified Jigsaw II under this heading. These techniques encourage cooperation among group members and competition between teams. Students learn assigned material for later recall, assist teammates in learning, and are rewarded on basis of combined performance of individual team members. Slavin (1987a; 1987b; cited in Bohlmeier & Burke, 1987) attributes the superior academic achievement attained through use of these methods to the incorporation of group contingencies or rewards which fosters group interdependence by preventing the most competent students from doing the majority of the work. He believes that having students work toward a group goal is not enough--- success in achieving this goal must be based on the sum of individual learning performances of all group members. Noddings (1989) and Slavin (1985, 1986, cited in Nastasi & Clements, 1991) state that these methods have been most effective in improving basic skills in mathematics and language, especially for minority students, and in developing more positive interpersonal relationships. Compared to traditional instruction, TAI was also found to improve students' attitudes and self-concepts towards

mathematics, the subject for which it was designed.

Stevens et al. (1991) and Slavin (1987a) describe another team method of cooperative learning called Cooperative Integrated Reading and Composition (CIRC) which incorporates direct instruction in language skills, cooperative learning, and group rewards. While the teacher is instructing other classmates, the remaining students work in pairs on reading and writing activities which are specifically designed as meaningful, follow-up tasks to their previous lessons. Quizzes are given when both partners feel that they are ready. Students in the upper elementary grades who participated in CIRC activities attained significantly higher scores on standardized tests of reading, language mechanics, and language expression than did students who received traditional instruction.

The techniques of cooperative learning developed by Johnson and Johnson (1991; 1990a; 1990b) are not as neatly encapsulated in specific models like the ones described previously. Their flexible methods can be implemented in a variety of stages, topics, and age groups. Formal, informal, and base groups are used for learning academic and collaborative skills. Bohlmeier and Burke (1987) and Nastasi and Clements (1991) give more detailed descriptions of two of the Johnson and Johnson methods which they respectively label collaborative task completion and circles of learning. In both of these approaches, the teacher

assists members of heterogenous groups in various stages including defining the task to be completed, outlining the necessary steps, choosing the most effective strategies, and assigning specific roles (clarifier, observer, summariser, recorder, encourager, questioner, organiser, and time-keeper). The amount of teacher-provided guidance and structure varies according to student needs.

Implementing cooperative learning.

Rather than adhering to one model of cooperative learning, teachers may find that it is more practical to implement a generic form of collaborative learning. Hill and Hill (1991), Slavin (1987a), Johnson and Johnson (1991; 1990a; 1990b) and Robertson (1990) among others have provided many practical suggestions for classroom implementation. Emphasis is placed on creating a caring climate of trust and support where cooperation is valued and the authority of each learner is honoured. Specifically, in the beginning of the school year, emphasis should be placed on team-building activities and the building of positive interpersonal skills, with these skills further developed throughout the year. The use of pairs and small, heterogeneous groups of three to five members is recommended. Careful monitoring is needed to ensure that all five elements of true cooperative learning are present. Cognitive conflict is resolved via the shared knowledge of

the group. Scaffolding is provided by the members of the group as well as through teacher guidance. An ever-increasing amount of decision-making and responsibility is given to students so that their classroom experiences reflect the democratic processes of our society. For the purposes of this study, this generic approach to cooperative learning will be used.

Benefits of cooperative learning.

One of the main goals of education is to increase academic achievement and cognitive development. Cooperative learning has been shown to be an effective way of increasing student learning across a wide variety of subject areas (Davidson & Shearn, 1990; Gabbert, Johnson, & Johnson, 1986; Lambiotte et al., 1987; Watson, 1991; Yager et al., 1986).

Gabbert et al. (1986) compared the effects of individual and cooperative learning situations on achievement and attitudinal scores of 52 Grade One students. Seven different tasks based on Bloom's cognitive levels were devised (missing addends, story problems, creature cards, triangles, circles, hypothetical situation, and categorization-memorization-retrieval). Students were randomly assigned to either individual or small groups conditions. Results showed that students who worked in cooperative groups achieved higher results on all seven tasks compared to students who worked alone. Students in

the cooperative condition also used higher level reasoning strategies than did students in the individual condition, and there was considerably more group-to-individual transfer over three post-training tasks involving higher-level thinking skills (analysis, synthesis, and evaluation). Three attitude scales (peer academic support, cooperation, individualistic) were also given to each child. Students in the cooperative condition reported more academic encouragement and support than did students in the individualistic condition.

Watson studied the use of Group Educational Modules (GEM) and cooperative learning and examined their effects on the achievement of 715 high-school biology students as compared to students receiving traditional classroom instruction. In the first condition, heterogeneous groups worked towards a common goal using self-instructional materials (Group Educational Models) and a collaborative approach similar to Aronson's Jigsaw model. Group incentives were included. Students in the second condition also used the GEM materials but they did not use cooperative learning techniques. The third condition involved the use of traditional materials and cooperative learning procedures. Students in the control condition worked independently using traditional materials. Students in the first and second conditions who used Group Educational Modules achieved higher results on a 50-item multiple choice

biology test than did students in the third and fourth conditions who used traditional materials. Significant differences in test results were also found between students in the two cooperative-learning conditions and those in the traditional-learning conditions. The use of Group Educational Modules in combination with cooperative learning did not facilitate learning more so than either approach alone. Both the use of Group Educational Modules and the use of cooperative learning techniques were perceived by the students to be more enjoyable than the traditional approach.

In addition to increasing achievement, cooperative learning also has positive effects on other educational goals such as developing sound emotional health and fostering positive social relationships. Johnson and Johnson (1990a, 1991) presented the weighted findings of a meta-analysis of over 500 studies carried out in the last 90 years that compared the relative effectiveness of cooperative, competitive, and individualistic efforts. They found that cooperative learning has a positive affect on the interconnected areas of students' self-esteem, achievement, productivity, interpersonal relationships, and social support.

Johnson, Johnson, Buckman, and Richards (1985) examined the relationship between social support and cooperative learning, the frequency of cooperative learning experiences and social support, and the relationship between long-term

cooperative learning and social support. The Classroom Life Instrument (a 59-item Likert-type questionnaire involving 12 factors of social support) was administered in November and January to 91 Grade Eight students. Findings indicated a high positive relationship between cooperative learning and social support, and that the longer and more frequently students participated in cooperative learning, the greater the social support was within the classroom.

Today's students exhibit a wide range of abilities and ethnic backgrounds. Teachers must ensure that each individual learns to the best of his or her ability and that individual differences are not only tolerated but are respected. Several researchers (Green & Myers, 1990; Mesch et al., 1988; Slavin, 1987a, 1987b) state that small group learning promotes positive race and gender relations and facilitates the mainstreaming of special education and handicapped students into the regular classroom.

Cooperative learning is especially appropriate for today's changing society as it provides individuals with the skills and qualities that are necessary for productive and fulfilling lives. The synergy it creates enables and empowers people to become agents of change as they problem-solve in collaboration with others. Through the use of cooperative learning "maybe students and teachers alike will learn the most important lesson of all---that the planet, the species and the individuals all benefit from

cooperation, within which the real competition, the Olympic model of doing one's best, can flourish" (Heywood, 1990, p. 299).

Structure and Strategies

Remembering new facts is an important part of the learning process. Pressley et al. (1990) cite studies indicating that, for the most part, students have difficulties acquiring factual knowledge. "Left to their own devices, students often adopt a passive, read/reread strategy for learning textbook material. Even conscientious learners often use only weak strategies such as underlining or verbatim note taking" (Lambiotte et al., 1988, p. 104). Harris and Pressley (1991) and Woloshyn et al. (1990) report that recent research demonstrates that children need to be more actively involved both in generating information, and in developing their own knowledge, for true understanding to occur. Specifically, students need to be encouraged to become actively engaged with both the material and the learning process in order for the deep processing that facilitates long-term memory to occur (Harris & Pressley, 1991; Paris & Winograd, 1990).

Active learning can be achieved in cooperative learning situations where students interact with one another through group discussions, study groups, or team projects. However, it is important to structure these cooperative experiences

so that beneficial results are more likely to result (Lambiotte et al., 1987). To assist with this procedure, students need to be made aware of not only the importance of various strategies and how to use them, but also of how and when to select a particular strategy that is appropriate for each particular task (Harris & Pressley, 1991). When learning factual material, several mental activities have been found to be effective. These include: making multiple passes through the material (the SQ3R method), using metacognitive processes (being aware of one's own understanding or difficulty and selecting appropriate strategies), and the use of elaboration and/or imagery strategies that connect and integrate information into existing concepts (Lambiotte et al., 1988). Moreover, Lambiotte et al. (1988) state that "a powerful approach for encouraging students to learn and implement these strategies is to provide training using a cooperative learning script" (p. 104).

A study undertaken by Stevens et al. (1991) examined the impact of direct instruction on reading comprehension strategies and the influence of cooperative learning processes on the learning of strategies by students. Four hundred and eighty-six students from Grades Three to Four were randomly assigned to one of three conditions: direct instruction with cooperative learning, direct instruction, and traditional instruction. All students used the same

basal reading material and answered questions involving details, inference, and main ideas. Students in the first two conditions achieved significantly higher scores on a 20-item multiple choice posttest than did students in the control group. Students in the cooperative learning-direct instruction condition did slightly better than those students who received direct instruction on an individual basis.

Elaborative Interrogation

There is great deal of research to support the use of elaboration strategies (adding details to to-be-learned information) as an effective way to promote the learning of new material (Gagné, 1985; Lambiotte et al., 1987). Within this tradition, the effectiveness of a strategy called elaborative interrogation has recently been investigated. This procedure involves asking why questions ("Why is that fact true?") about to-be-learned material in order to activate relevant prior knowledge. Several studies have indicated that elaborative interrogation effectively promotes learning relative to reading for understanding for a wide variety of subject matter and can be used effectively by young learners as well as by adults (Pressley et al., 1990; Woloshyn et al., in press; Woloshyn, et al., 1992; Woloshyn et al., 1990; Wood et al., in press; Wood et al., 1990).

Studies with Adults

In one study with 80 adult learners, Woloshyn et al. (1990) found that elaborative interrogation was as effective as imagery, a strategy well known to promote learning, and a better strategy than self-referencing in helping undergraduate students learn facts about different universities. Even when the subjects were unable to generate adequate responses (logical explanations) to the why questions, their achievement on three memory tests was consistently higher than the achievement of those subjects in the reading-control condition. In every instance but one, the quality of response did not impact significantly on learning. The only exception was that facts associated with adequate explanations were remembered better than were facts associated with inadequate responses (answers that did not make clear why the given facts were true).

Wood et al. (in press) also found that elaborative interrogation could be used successfully by undergraduates in both large and small group settings. One hundred and twenty subjects were randomly assigned to one of three study contexts: individuals, small groups of five, and large groups of twenty. Half of the participants in each study context were assigned to a repetition-control condition while the other half were given instructions to use elaborative interrogation as they studied. Recall of "man" statements ("The tall man bought the crackers") by students

using elaborative interrogation did not differ as a function of group size and was significantly better than that of students in the repetition-control condition. The authors speculated that elaborative interrogation might encourage the simultaneous use of other helpful techniques such as imagery and verbal strategies.

In another study with adult learners, Woloshyn et al. (1992) compared the use of elaborative interrogation where learners possessed either high prior knowledge about target information or low prior knowledge about critical content. One hundred Canadian and German undergraduates were randomly assigned to one of three conditions: elaborative interrogation, reading-to-understand, and no-exposure control and were asked to study facts about Canadian provinces and German states. Results indicated that both prior knowledge and strategies were needed for optimal performance. However, the use of elaborative interrogation without relevant prior knowledge still promoted learning, perhaps because of the cognitive effort and/or deep processing that it involved.

Wood and Reilley (1993) compared the retention gains of 40 undergraduates who studied familiar and unfamiliar animal facts using either elaborative interrogation or a strategy of choice. Since students were also instructed to work in pairs for half of the target facts and on their own for the other half, this study also compared individual

versus dyadic gains. Although there were no main effects for study context or study condition, further analysis revealed that some undergraduates in the self-study condition reported using advanced strategies such as imagery. More facts were recalled for familiar animals than unfamiliar animals, especially when students studied in pairs. Wood and Reilley suggest that dyadic study may be most beneficial when learners have sufficient prior knowledge about the to-be-learned material.

Studies with Children

Studies have also been undertaken to determine whether elaborative interrogation would encourage younger students to access relevant prior knowledge and thus improve their learning. In their first experiment, Wood et al. (1990) randomly assigned 139 students from Grades Four to Eight into four conditions: base sentence, precise elaboration provided, imagery, and elaborative interrogation. Results revealed that students who used either imagery or the elaborative interrogation strategy did better in their recall of "man" statements ("The hungry man went into the car") than did students in the reading-control condition. For those students above the median age of 11 years, 7 months, the ones who used elaborative interrogation also recalled significantly more "man" statements than did those in the elaborations-provided condition.

In their second experiment involving 257 students from Grades Four to Eight, the use of elaborative interrogation promoted greater retention of more ecologically valid material (facts about familiar animals) than did self-study or having elaborations provided. In contrast to the first experiment, the use of imagery did not produce significantly higher results when compared to other conditions. In contrast to the results in their first experiment and to all of the relevant findings from adult studies, the production of any explanation at all during study increased the probability of subsequent recall relative to failure to respond. Furthermore, scientifically correct elaborations which provided logical and accurate explanations of why the facts were true ("The blue whale prefers to be near the surface of the water because it's a mammal and it has to breathe air") were associated with greater recall when compared with inaccurate elaborations (logical explanations that were not based on relevant scientific information, "The emperor penguin never makes a nest or home to hide in because they don't have any fingers or materials to build with") or inadequate responses (answers that did not make clear why the given facts were true, "The townsend mole lives in tunnels because he likes it there"). Wood et al. believe that the use of elaborative interrogation might be more effective for those students who are familiar enough with the to-be-learned material that

they are able to produce accurate elaborations.

In their two experiments studying the use of elaborative interrogation to help Grade Six and Grade Seven children overcome science misconceptions, Woloshyn, Paivio, and Pressley (in press) also found that elaborative interrogation was a more effective strategy relative to reading for understanding. Even when students were unable to provide adequate responses or failed to respond at all, their recall and recognition of study material exceeded that of students in the reading-control group. Facts associated with adequate responses were retained better than were facts associated with response failures for immediate sentence selection in Experiment One and for cued recall in Experiment Two. Superior learning gains for students using this strategy were sustained when the 40 subjects were tested after 14-day, 75-day, and 180-day intervals. In general, students recognized more novel facts about the four science topics (solar system, circulatory system, plants, and animals) than they did facts that addressed common misconceptions. Students in the elaborative-interrogation condition rated their task as more difficult than did students in the reading-control condition. Since authors believe that the use of elaborative interrogation in pairs or small groups is also likely to promote learning, research in this area was suggested.

In order to explore the use of elaborative

interrogation with dyads Woloshyn and Gage (1993) carried out another experiment comparing the effectiveness of elaborative interrogation when used individually or by pairs of students. Scientific facts identical to those used by Woloshyn et al. (in press) were also used in this study. Thirty sixth-grade and 34 seventh-grade students were randomly assigned to individual or dyadic conditions and instructed to use elaborative interrogation as a study strategy. There were no significant differences in recall between the two conditions on the following measures: immediate free recall, and immediate, 30-day, and 60-day recognition. For immediate cued recall, those students who studied alone retained significantly less information than did those who studied with a partner. Results from this study suggest that continued research on the use of elaborative interrogation in group settings would be worthwhile.

Present Study

Both cooperative learning and elaborative interrogation have been shown to be effective ways of promoting active learning. Much of the earlier research in the area of elaborative interrogation has been conducted under laboratory-based conditions (Harris & Pressley, 1991; Woloshyn, et al., in press). This study was designed to determine the effectiveness of elaborative interrogation in

a more ecologically valid learning context where students were heterogeneous with respect to their prior knowledge of to-be-learned material. Specifically, this study investigated whether elaborative interrogation plus cooperative learning facilitated learning of relevant information more so than either approach alone. Retention gains of students in the three experimental conditions were also compared to those of students in a reading-control condition. The relationship between the types of elaborative responses and subsequent retention was also examined.

The 68 students were initially given training and practice in cooperative-learning techniques. Extensive fieldnotes of the students' progress were kept. The subjects were then randomly placed in the following four conditions: elaborative-interrogation-plus-cooperative-learning ($n=16$), cooperative-learning ($n=16$), elaborative-interrogation ($n=19$), and reading-for-understanding ($n=17$) (control) and asked to study statements about familiar animals. Sessions were tape-recorded and subsequent transcripts were analyzed for the quality of response provided and for the nature of the group discussions. Retention was assessed via immediate free recall, immediate associative matching, and two long-term associative matching tests (30-day and 60-day). The relationship between quality of elaborative response given during study and the

probability of subsequent recall was examined for students in the two elaborative-interrogation conditions. In addition, a 13-item questionnaire was used to gain insight into the students' enjoyment of their assigned tasks, perceptions of competence, and perceptions of task difficulty.

Hypotheses

- 1) Students in the cooperative-learning condition would achieve both greater short-term and long-term retention scores on the dependent measures of free recall and associative matching as compared to students in the control group.
- 2) Students in the elaborative-interrogation condition would achieve both greater short-term and higher long-term retention scores on the dependent measures as compared to students in the control group.
- 3) Retention results of students in the elaborative-interrogation-plus-cooperative-learning would be different on the dependent measures than would the retention scores of students in either the cooperative-learning or the elaborative-interrogation conditions; however, they would be higher than the results of students in the control group.
- 4) For both subjects in the elaborative-interrogation and in the elaborative-interrogation-plus-cooperative-learning, the quality of response given for each fact during study would

affect the probability of subsequent retention. Generation of adequate elaborations would be associated with greater likelihood of recall than generation of inadequate responses or failures to respond.

5) The degree of enjoyment of the experience would be higher for those students in the two cooperative conditions than for those in both the individual elaborative-interrogation and the reading-control conditions.

6) The self-evaluations of performances would vary for students in each of the four conditions since those who were using elaborative interrogation and/or were working in groups would be more actively engaged and hence would gain more metacognitive awareness.

7) The assigned study task would be rated as more difficult by those students who used elaborative interrogation either in a group or individually than by those students in the control group or in the cooperative group.

CHAPTER THREE: METHODOLOGY

Overview of the Chapter

The methodology of this experiment was similar to that which was used by Wood, Pressley, and Winne (1990) in their study of the effects of elaborative interrogation on children's learning of factual knowledge. In addition, cooperative-learning techniques advocated by Johnson and Johnson (1991; 1990a; 1990b) were incorporated into this study. Extensive fieldnotes were kept to provide qualitative data. Previously tested material (36 animal facts) was studied by 68 Grade Six students randomly distributed into four experimental conditions (elaborative-interrogation-plus-cooperative-learning, cooperative-learning, elaborative-interrogation, and reading-control). Immediate free recall, immediate matched association, 30-day matched association, and 60-day matched association measures were used to assess retention gains. A priori comparisons were made to determine differences due to study context. Students' opinions about the study session were obtained via a 13-item questionnaire. Transcripts of the tape-recorded sessions were analyzed and conditional probabilities were calculated to determine the relationship between quality of response given for elaborative interrogation and subsequent recall. Planned pairwise comparisons were then conducted.

Subjects

Sixty-eight English-speaking students (35 males, 33 females) ranging in age from 11 years, 1 month to 12 years, 7 months (\bar{M} age=11 years, 6 months) were selected from four, Grade Six classrooms in two neighbouring public schools located in a middle-class neighbourhood to participate in this study. Included in this sample were six students who had received English as a Second Language (E.S.L.) instruction in Grades Four and Five as well as five exceptional students with Specific Learning Disabilities (S.L.D.) who had been mainstreamed into the regular classroom settings during Grade Five and Grade Six. No students who had been deemed exceptional in the gifted area were included in this study; however, eight students who had been designated as mode 2 (brighter than average) were included. In other words, each classroom had a heterogeneous mix of students rather than a streamed or clustered grouping of children. All participating students' parents completed parental permission forms (see Appendix A).

Students were first randomly assigned to one of the four study conditions: elaborative-interrogation-plus-cooperative-learning, cooperative-learning, elaborative-interrogation, and reading-for-understanding (control). The 16 students in the first two conditions (elaborative-

interrogation-plus-cooperative-learning, cooperative-learning) were then assigned to small groups of four students making a total of eight groups. Both the classroom teachers and the students had some input into the formation of the small groups, however, a balance of ability between the groups was maintained so that no one group consisted of all bright learners or students with English difficulties or with other specific disabilities. Specifically, high-, mid-, and low-achieving students were identified by Canadian Cognitive Abilities Test (CCAT) and Canadian Test of Basic Skills (CTBS) scores, as well as report card achievements, all of which were found in their Ontario Scholastic Records (OSR). The input of the classroom teachers as to students' abilities was also considered. Boys and girls were equally distributed across the small groups. Students in the last two conditions (elaborative-interrogation, reading-control) were seen individually.

Material

Material that the students might realistically encounter in a school setting was used. In order to make the to-be-learned material typical of what students would naturally encounter in their classrooms, entire paragraphs of information, rather than isolated statements, were presented. Six animal stories that had been tested by Wood et al. (1990) were selected. Based on previous studies, it

was assumed that although sixth-grade students were likely to have some prior knowledge about animals in general, the facts about these particular animals were not likely be familiar to them. The six animals covered in the stories included: the Western Spotted Skunk, the American Pika, the Little Brown Bat, the Blue Whale, the Emperor Penguin, and the Townsend Mole (complete stories listed in Appendix B). A total of 36 to-be-learned facts was used in order to avoid a ceiling effect during testing.

Each animal was described in six sentences which stated facts about diet, sleep habits, habitat, and major source of predation. Each paragraph was typed on white paper which was then laminated onto bristle-board cards each measuring 12 cm x 19 cm. Four copies were made of each story so that each child in a group would have his/her own copy. Accompanying every animal was one 19.2 cm x 24 cm colour picture.

The following is an example of an animal story which is based on the life of the Western Spotted Skunk.

The Western Spotted Skunk lives in a hole in the ground. The skunk's hole is usually found on a sandy piece of farmland near crops. Often the skunk lives alone, but families of skunks sometimes stay together. The skunk mostly eats corn. It sleeps just about any time except between three o'clock in the morning and sunrise. The biggest

danger to this skunk is the great horned owl. (Wood et al., 1990, p. 744)

The stories were also recorded on audio-cassette by a male adult. Each story was read in its entirety and then the six sentences were repeated separately. Following each statement, there was a pause of 35 seconds during which the study conditions were applied. Each pause was followed by a bell indicating that the 35 seconds allocated to study were finished and that students were to continue to the next fact. The remaining five stories were processed in an identical manner. Each of the study sessions was tape-recorded in order to provide data on students' responses for further analysis.

The story entitled "The House Mouse" (Wood et al., 1990) was also used in this experiment as a practice sample. Students had an opportunity to read over this passage and to practise the strategies that were part of their treatment group. Appropriate feedback was provided to each group. Immediately following the practice story, the six stories were studied.

Procedure

Pilot Study

A pilot study of elaborative-interrogation-plus-cooperative-learning was undertaken with a group of four

Grade Six students from a different school to confirm that the animal facts presented students with new information and to determine the amount of time necessary to process the stories. The material and procedure used for this pilot study were identical to those used for Condition One of this experiment.

Cooperative Learning

During September and October, a minimum of two 40-minute visits were made to each of the four classrooms involved in the study in order to observe the social dynamics and to informally assist the classroom teacher. The students were also asked to complete a two-page personal survey to allow this researcher to become more acquainted with the children.

During November and December, all students were given instruction, training, and practice in cooperative learning techniques during three 45-minute sessions. Some of the activities included cooperative gym games (Untangle), word puzzles (Mindbenders), group-building tasks (Boundary Breakers), and an activity called International Simulation. In this latter activity, members of various groups assumed different nationalities and attempted to solve their country's problems by balancing its needs and resources and by interacting with members of other countries. Time was provided at the end of each session for the students to

reflect on their use of appropriate cooperative skills. Fieldnotes were kept for each session.

These collaborative techniques were believed to be beneficial for all students whether or not cooperative learning was part of the treatment in which they were later involved. In addition, these classrooms were chosen because the homeroom teachers in charge typically used many cooperative learning strategies on a regular basis and had expressed an interest in involving their students in this process. The four classroom teachers supplemented the researcher's training sessions with many other cooperative activities during the school terms in which this experiment took place.

Study

Following the cooperative-learning practice sessions, the subjects were tested in either small groups of four (Conditions One and Two) or individually (conditions Three and Four) in a separate room of their school. As this was a test of intentional learning, all students were told that they would be asked about the animal facts immediately following the presentation of the six stories.

Students in the cooperative-learning condition were also reminded to work collaboratively while they were learning the material. These students were told that working together, or working cooperatively, had been found

to be a useful strategy for improving memory and that if they discussed the information with each other, they would probably find it easier to later remember the new facts. Students in the elaborative-interrogation-plus-cooperative-learning condition were given the previous instructions and were also informed of the effectiveness of the elaborative-interrogation strategy. They were reminded to try their best to answer the why questions even if they were not sure that their answer was correct. Emphasis was placed on teamwork and cooperation for students in the cooperative-learning and in the elaborative-interrogation-plus-cooperative-learning conditions.

Students in the individual elaborative-interrogation condition were told that this strategy had been found to be a helpful way of improving memory and were encouraged to attempt to find answers to the why questions even when they were uncertain about the accuracy of their responses. Students in the control condition were asked to read the stories for understanding carefully in order to remember the details.

The sample story was used to provide students with an opportunity to practise their respective study instructions and to receive appropriate feedback and praise. Modelling of appropriate elaborations was provided by the researcher during the practice session.

Instructions

The following general instructions were given to each group immediately following the practice session.

Today you will read about and listen to six short animal stories. Read each statement quietly to yourself as you listen to the cassette. After you hear one whole story, you will hear the first statement again. Your task is to try to remember this fact. At the sound of the bell, you will hear the second statement. Again, you are to try to remember this fact. Each time you hear the bell, please study the next statement. There are six facts for each animal. Here is the first story.

The first story was then presented.

For the elaborative-interrogation-plus-cooperative-learning condition, the following instructions were added.

For each statement I would like you to discuss with the other members of your group why you think the fact about the animal is true. Think about all the information you have just heard and read, as well as anything else you might have learned in class or somewhere else to help you find some answers. Remember to let everyone have a turn and to listen carefully to other people's answers as they may help you learn about the animal. It's all right to guess if you're not sure. There are many correct reasons

why these facts are true. Please speak clearly as I will be tape-recording your responses.

For the cooperative-learning condition, these instructions were added to the general ones.

I would like you and your group to talk about each of the sentences you hear and read. Remember to let everyone have a turn and to listen carefully to other people's statements as they may help you learn about the animal. Please speak clearly as I will be tape-recording your responses.

For the elaborative-interrogation condition, the following instructions were included.

I would like you to try to answer why you think each statement about the animal is true. Think about all the information you have just heard and read as well as anything else you might have learned in class or somewhere else to help you find some answers. Remember that it's all right to guess if you're not sure. There are many correct reasons why these facts are true. Please speak clearly as I will be tape-recording your responses.

For the reading-control condition, these instructions were added.

I would like you to read each sentence aloud as you think about and study the fact. Reread each fact at a normal speed as many times as possible. Please speak

clearly as I will be tape-recording your reading. No further feedback was provided after the initial story, although processing instructions were reiterated when necessary.

Memory Tests and Questionnaire

After the presentation of the six stories, individual students were given a free recall test. Papers and pencils were handed out, with the names of the six animals provided on the papers (see Appendix C). Subjects were given as much time as necessary (approximately 15-20 minutes) to jot down all the information they could remember about each animal under the appropriate headings. They were told to use their own words and point form.

A recognition test was given immediately following the free recall test. This was an associative matching quiz containing 36 statements with a blank preceding each statement (see Appendix D). Students were again given as long as they needed (approximately 10-15 minutes) to fill in the blanks with letters corresponding to the correct animals. The names of the six animal choices were provided at the top of the paper.

At the end of this session, the students were also asked to fill in a brief questionnaire seeking their opinions about the study experience. These questions assessed students' perceptions of performance, enjoyment of

the session, and of task difficulty and efficiency, and are listed in Appendix E. This task was included because "there have been suggestions that the use of efficient strategies may itself be related to one's knowledge and awareness about the nature of the cognitive activity and of the person and task variables which influence such activity" (Marfo & Ryan, 1990, p. 241). A Likert scale with ratings varying from 1 (not very) to 5 (a great deal/very) was used. A space was provided at the bottom of the questionnaire where students were encouraged to write down any other thoughts or feelings they had about their experience in the study. They were then thanked for their cooperation and participation.

The total time for the test session ranged from 50 minutes to 95 minutes depending on the time needed for the initial practice and for the completion of the two tests and the questionnaire. Because of the variety of activities involved and the novelty of the experience, this was not an overly long session for children of this age to maintain concentration and a high level of performance.

The subjects were given the identical matched association task after 30-day and 60-day intervals in order to assess their long-term retention. Upon completion of the entire study, the students were called together to be debriefed and thanked once again.

Analysis

The observations and fieldnotes made during the cooperative training and practice sessions and during the testing sessions provided the qualitative data for this study. However, the majority of data from this study was quantitative in nature. Because the test scores involved interval scales, parametric statistics were used to analyze the results. A priori planned pairwise comparisons were made to determine differences between the performances of subjects in the four study conditions for each of the dependent measures (immediate free recall, immediate matched association, 30-day and 60-day matched association).

Transcripts of the elaborative-interrogation-plus-cooperative-learning and elaborative-interrogation sessions were analyzed for types of responses provided during study. Conditional probabilities were calculated to determine the relationships between attempts to generate a response, appropriateness of response, and subsequent performances on the memory measures. A priori t tests were then conducted.

Students' free recall responses were scored for errors. ANOVAs were run to see if there were main effects due to study condition. Pairwise comparisons were subsequently made following significant F values.

Transcripts of the tape-recorded conversations of the subjects in the cooperative-learning condition were also examined for descriptive details about the types and quality

of remarks. As well, the questionnaire responses were examined to discover if students' perceptions about task difficulty and strategy efficiency, as well as their enjoyment of the session and self-evaluations of performance differed between the study conditions.

CHAPTER FOUR: RESULTS

Overview of the Chapter

The qualitative data obtained via fieldnotes revealed that subjects in two of the four classrooms were not as proficient in the use of cooperative-learning techniques as were students in the other two classrooms. By the time of the testing sessions, considerable improvement of collaborative skills was noted. Differences in application of the study instructions within the study conditions were observed.

Retention results from the two immediate measures revealed significant differences favouring subjects in the three experimental conditions versus subjects in the control condition. Subjects in the elaborative-interrogation-plus-cooperative-learning and in the elaborative-interrogation conditions achieved significantly higher results on the 30-day matched association test than did control subjects. On the 60-day test, scores of students in the elaborative-interrogation condition were significantly higher than those of students in the control condition.

For subjects in the elaborative-interrogation-plus-cooperative-learning and in the elaborative-interrogation conditions, the quality of response given for each fact during study affected the probability of subsequent retention. In general, analyses revealed that those facts

for which adequate elaborations were provided were associated with significantly greater probability of recall than were facts with inadequate answers, no responses, or supporting responses.

During free recall, few errors were made by the subjects. More irrelevant statements were made by subjects in the cooperative-learning condition than subjects in the control group. Students in the elaborative-interrogation-plus-cooperative-learning condition made more incorrect statements relative to control students. For the questionnaire responses, there were no significant differences due to study condition.

Analyses of Qualitative Data

Observations of Informal Visits

In two of the classes that were visited in September and October, some of the students appeared to be somewhat immature and lacking in well-developed social skills. Considerable time was being spent by the homeroom teachers in dealing with discipline issues for a few disruptive members and in trying to build a sense of cohesiveness in the class. As yet, the paired and group activities that had been attempted were not handled effectively by all the children. It was evident that some of the children needed greater training and experience with cooperative learning.

The two teachers and the researcher agreed that much modelling of appropriate behaviours and techniques was required before the majority of the class could successfully attempt true collaborative endeavours. As a result, the researcher spent additional time in these classrooms informally assisting with group activities such as baking, map skills assignments, French seatwork, and art collages. By the end of November, the few disruptive students had begun to participate more successfully in the daily routines of the classroom and there was a definite improvement in the social skills of other members of the class. Observations, conversations, and anecdotal records of the teachers and the researcher revealed fewer incidences of uncooperative behaviours such as arguments, blurting out of answers and opinions, lack of sharing of equipment and assistance, and unwillingness to work with certain individuals or to participate in group activities. The researcher believed that the more formal cooperative training sessions of this study could now be successfully implemented.

In contrast, the students in the other two classes appeared to have more highly developed social skills and had been successfully involved in many cooperative activities (cooperative book making, map skills, imaginary island creations) since the start of the school year. As well, the children had spent time discussing issues involved in cooperative learning during their twice weekly 45-minute

Values, Influences, Peers (V.I.P.) classes. While facilitating group work on the creation of a unique island and while leading a discussion on peer pressure, this researcher observed that the students were using effective cooperative skills such as listening to others, taking turns, problem solving collaboratively, giving constructive criticism, offering suggestions, and engaging in ongoing reflection. The positive, cohesive atmosphere that existed in these two classrooms was apparent through observation and was confirmed through conversation with the classroom teachers. It was also believed that these students were ready to engage in the more formal cooperative training sessions of this study.

Observations of Cooperative Training Sessions

Many fine examples of what constituted true cooperative learning were generated during the initial discussions with each class. At the start of the activities, only a few students experienced some initial difficulty finding a group they wanted to work with, however, compromises were made which were agreeable to all. Most groups initiated the selection of chairperson and recorder on their own, however, some groups needed reminders to do so. The vast majority of the students worked enthusiastically and cooperatively on the planned activities during all three sessions and required only minimal intervention.

Students were observed discussing different points of view, building on each other's ideas, brainstorming solutions, resolving differences by putting various suggestions to a vote, demonstrating persistence, and encouraging each other. On rare occasions, reminders were still needed to let everyone express their ideas, to problem solve more democratically, and to express criticism in a more constructive manner.

During the discussions that followed each activity, the students were able to realistically reflect about how well they had worked together, what difficulties they had experienced, and how to resolve their differences in the future. They could identify which cooperative skills they had successfully demonstrated and which ones needed more work. Observations of the final session revealed a growth in the use of collaborative skills for all four classes.

Observations of Testing Sessions

Analyses of fieldnotes and transcripts from the tape-recorded sessions revealed that students in the elaborative-interrogation-plus-cooperative-learning condition followed task instructions well. In two of the four groups, all members participated equally and fully in generating elaborations. In one group, an academically strong female student was quiet throughout much of the session and in another group an academically weak female student

volunteered an answer only once during the entire session. In three of the groups, the discussion was quite lively as students frequently built on each other's ideas and voiced their own opinions. When overly enthusiastic, students responded well to reminders to allow others to finish their sentences. The tape-recorded bell which signalled them to turn their attention to the next target fact nearly always interrupted the discussion. On the other hand, members of the fourth group sometimes hesitated before elaborating on the facts and didn't build on each other's thoughts as often as did members in the other three groups. There were occasionally pauses of silence between targetted facts. In all four groups, opinions were usually voiced in a conversational tone and no "put downs" were used when disagreements occurred. The use of compliments was infrequent.

Analyses of fieldnotes and transcripts of the tape-recorded sessions revealed that students in each of the four cooperative-learning groups followed task instructions (to discuss the material in a way that would help everyone remember the information) in a different fashion. One group spent the entire session reviewing the facts by asking each other lower-level questions ("Where does the townsend mole live?"). To ensure that each member participated equally, the person who answered one question had to think of a question to ask the next person. This group conducted a

question/answer session rather than having a true conversation about the information. Two of the other groups had lively discussions about each animal with each member contributing equally. Prior knowledge was shared, facts were connected, and higher-level thinking skills were revealed as members filled the entire time with their discussions. In the fourth group, one of the group members initiated why questions and the other members followed this type of questioning throughout the entire session. Although every member participated and some prior knowledge was shared, the session didn't develop into a lively discussion.

Students in the elaborative-interrogation condition followed study instructions well and usually were able to provide at least one explanation for why the fact was true within the first 20 seconds. There were no instances where an individual was incapable of generating either an adequate or an inadequate response for any of the animal facts.

Students who were required to repeat each fact several times during the study pause consistently followed instructions. Repetitions ranged from 13 to 20 for the shortest sentence ("The skunk mostly eats corn") and from 3.5 to 7 for the longest sentence ("Although Antarctica is cold all of the time, the emperor penguin sleeps longer when it gets really cold"). Behaviours such as asking to get up for a drink or a stretch, chair-rocking, and fiddling with pencils and erasers were noted more frequently for members

in this condition than for members of the other three conditions.

Analyses of Quantitative Data

General Format

For each of the dependent measures (free recall, immediate matched association, 30-day matched association, and 60-day matched association), Dunn-Bonferroni and Dunnett multiple comparison a priori t tests were carried out to determine whether there were significant differences between the experimental groups and between the experimental and control conditions respectively (Kirk, 1982).

Responses of students in the individual elaborative-interrogation condition were scored with respect to whether they contained adequate elaborations (logical explanations of why each fact was associated with a particular animal) or inadequate explanations (nonexplanatory answers). Responses of students in the elaborative-interrogation-plus-cooperative-learning condition were rated as follows: no response, inadequate, adequate, and supporting responses (answers that provided further elaboration of a teammate's adequate response). For both conditions, adequate responses were further classified as accurate (scientifically correct explanations) or inaccurate (precise explanations that were not scientifically true). For each of the four memory

tests, item-by-item conditional probabilities were calculated to determine the relationship between the type of responses given during study and subsequent recall. Pairwise differences between the types of responses were then evaluated with separate sets of Dunn-Bonferroni contrasts for each of the four dependent measures to discover if there were significant differences between the quality of responses and retention.

Students' free recall responses were also analyzed for errors. Specifically errors were scored as either intrusions (facts that were presented during study but recalled in response to another animal), irrelevant statements (factual information that was not provided in the text), and incorrect statements (errors made on specific facts about the animals). For each error type, a one-way ANOVA was carried out to determine whether there were significant differences across the conditions. Because the sample sizes were unequal but similar, the Spjøtvoll and Stoline modified Tukey's Honestly Significant Difference (HSD) procedure was used to assess posthoc differences (Kirk, 1982).

A one-way ANOVA was also used to determine whether students responded differently on each of the items in the post-test questionnaire as a function of experimental condition. Spjøtvoll and Stoline modified procedure was used to determine posthoc differences.

Retention Results

The means and standard deviations for the four memory measures (free recall, immediate matched association, 30-day matched association, and 60-day matched association) are listed in Table 1 as a function of participation in experimental and control conditions.

Free Recall

Students' recall responses were scored as correct if they were verbatim matches or synonymous with the target information. This liberal scoring system was used to allow for the students' semantic conversions as they learned the new concepts. Two independent raters scored 20% of the data with an interrater agreement of 98%. Differences were resolved by discussion. Because of the high interrater agreement, the remaining responses were scored by only one of the raters.

Students in the elaborative-interrogation-plus-cooperative-learning, elaborative-interrogation, and cooperative-learning conditions recalled more factual information than did students in the repetition-control condition [$t(31)=3.24$, $p<.01$; $t(34)=2.64$, $p<.05$; $t(31)=2.15$, $p<.05$, respectively]. There were no significant differences between students' performances across the experimental conditions [$t(30)\leq 1.08$, $p>.05$].

Table 1

Means and Standard Deviations for Free Recall, Immediate Matched Association, 30-Day Matched Association, and 60-Day Matched Association as a Function of Condition

Condition	<u>M</u>	<u>SD</u>
Free Recall		
Elaborative-interrogation-plus-cooperative-learning	19.50	5.21
Cooperative-learning	17.31	5.74
Elaborative-interrogation	18.08	6.04
Reading-control	13.03	5.82
Immediate Matched Association		
Elaborative-interrogation-plus-cooperative-learning	30.06	5.13
Cooperative-learning	28.13	4.10
Elaborative-interrogation	29.32	4.50
Reading-control	24.24	6.22
30-Day Matched Association		
Elaborative-interrogation-plus-cooperative-learning	24.06	4.99
Cooperative-learning	21.56	6.45
Elaborative-interrogation	23.74	5.57
Reading-control	19.41	5.35

(table continues)

Table 1 (continued)

Condition	<u>M</u>	<u>SD</u>
60-Day Matched Association		
Elaborative-interrogation- plus-cooperative-learning	23.38	5.75
Cooperative-learning	21.27	5.51
Elaborative-interrogation	24.05	5.53
Reading-control	19.94	5.07

Note. Maximum score=36.

n= 16, 16, 19, 17 per condition.

Immediate Matched Association

Matching performances of students in all the experimental conditions exceeded those of students in the reading-control condition [elaborative-interrogation-plus-cooperative-learning $t(31)=3.30$, $p<.01$; elaborative-interrogation $t(34)=2.88$, $p<.01$; and cooperative-learning $t(31)=2.30$, $p<.05$]. Students' performances did not differ between the elaborative-interrogation-plus-cooperative-learning, cooperative learning, and elaborative-interrogation conditions [$t \leq 1.13$, $p>.05$].

30-Day Matched Association

Students in the elaborative-interrogation-plus-cooperative-learning and in the elaborative-interrogation conditions achieved greater 30-day matching scores than did students in the reading-control condition [$t(31)=2.38$, $p<.05$; $t(34)=2.31$, $p<.05$ respectively]. The results of students in the cooperative-learning condition did not differ from those of students in the reading-control condition [$t(31)=1.10$, $p>.05$]. There were also no significant differences in students' 30-day matching scores across the experimental conditions [$t \leq 1.26$, $p>.05$].

60-Day Matched Association

Matching performances of students in the elaborative-interrogation condition were superior to those of students

in the reading-control condition [$t(34)=2.35$, $p<.05$]. Students' performances in the elaborative-interrogation-plus-cooperative-learning and cooperative-learning conditions did not differ from those of students in the reading-control condition [$t(31)\leq 1.89$, $p>.05$]. There were also no significant differences in students' matching performances across the experimental conditions [$t \leq 1.54$, $p>.05$].

Relationship Between Elaborative Responses and Subsequent Learning

Two independent raters scored 20% of the students' study responses in both the elaborative-interrogation and in the elaborative-interrogation-plus-cooperative-learning conditions with an interrater agreement of 86.1% and 89.58% respectively. Students generally had little difficulty dialoguing for the entire study time (35 seconds per item). Since all subjects in the individual condition attempted to explain why the facts were true (there were no instances of response failures), their responses were scored as either adequate or inadequate. In the group condition, subjects received one of the following scores for each of the 36 facts: no response, inadequate response, supporting response, and adequate response. All adequate responses were further classified into accurate or inaccurate elaborations. Differences in rating were resolved through discussion. The remaining responses were scored by only one

of the raters.

For each of the dependent measures, the probabilities of correct recall associated with each response type are listed in Tables 2 and 3.

Free Recall

Elaborative-interrogation condition.

Adequate elaborations (both accurate and inaccurate) produced higher retention than inadequate explanations [$t(36)=8.98$, $p<.01$]. When the adequate responses were further classified, adequate and scientifically correct elaborations were associated with significantly better retention relative to inadequate answers [$t(36)=6.06$, $p<.01$] and adequate but incorrect elaborations [$t(36)=6.74$, $p<.01$].

Elaborative-interrogation-plus-cooperative-learning condition.

Adequate elaborations, both accurate and inaccurate, promoted significantly better retention than did supporting responses [$t(27)=5.44$, $p<.01$], no responses [$t(26)=4.01$, $p<.01$], or inadequate responses [$t(29)=2.84$, $p<.05$]. There were no other significant differences [$t \leq 3.06$, $p>.05$]; however the comparison between supporting response versus correct response approached significance [$t(27)=3.42$, critical $t=3.43$, $p>.05$].

Table 2

Means and Standard Deviations for Probability of Recall
for Each Response Type: Elaborative-Interrogation Condition

Means and Standard Deviations	Response Types			
	2	3	5	3/5
Free Recall				
<u>M</u>	.236	.199	.565	.765
<u>SD</u>	.183	.105	.201	.183
Immediate Matched Association				
<u>M</u>	.210	.206	.583	.789
<u>SD</u>	.179	.097	.182	.179
30-Day Matched Association				
<u>M</u>	.212	.198	.592	.788
<u>SD</u>	.196	.104	.193	.195
60-Day Matched Association				
<u>M</u>	.213	.183	.604	.787
<u>SD</u>	.171	.102	.165	.170

Note. n=19.

2=inadequate explanation, 3=adequate but incorrect
elaboration, 5=adequate and correct elaboration,
3/5=combined adequate elaborations.

Table 3

Means and Standard Deviations for Probability of Recall
for Each Response Type: Elaborative-Interrogation-Plus-
Cooperative-Learning Condition

Means and Standard Deviations	Response Types					
	0	2	3	4	5	3/5
Free Recall						
<u>M</u>	.206	.291	.151	.121	.314	.465
<u>SD</u>	.256	.130	.077	.068	.170	.182
Immediate Matched Association						
<u>M</u>	.213	.283	.161	.113	.311	.473
<u>SD</u>	.277	.138	.073	.056	.130	.178
30-Day Matched Association						
<u>M</u>	.212	.273	.147	.119	.335	.483
<u>SD</u>	.283	.159	.093	.063	.151	.198
60-Day Matched Association						
<u>M</u>	.189	.302	.153	.119	.319	.471
<u>SD</u>	.231	.139	.079	.059	.160	.184

Note. 0=no response (n=13), 2=inadequate explanation(n=16),
 3=adequate but inaccurate elaboration (n=15),
 4=supporting elaboration (n=15), 5=adequate and
 correct elaboration (n=15), 3/5=combined adequate
 responses (n=15).

Immediate Matched Association

Elaborative-interrogation condition.

Retention of items for which adequate elaborations were generated was superior to those with inadequate responses [$t(36)=9.98, p<.01$]. Further comparisons revealed that scientifically correct elaborations were associated with significantly better recall than either incorrect elaborations [$t(36)=7.35, p<.01$] or inadequate responses [$t(36)=7.27, p<.01$].

Elaborative-interrogation-plus-cooperative-learning condition.

Items associated with adequate responses were retained better than were items associated with supporting responses [$t(27)=5.50, p<.01$], no responses [$t(26)=3.90, p<.01$], or inadequate responses [$t(29)=3.00, p<.05$]. There was only one other significant difference found. Facts elaborated on correctly were retained better than those that were associated with supporting elaborations [$t(27)=3.51, p<.05$].

30-Day Matched Association

Elaborative-interrogation condition.

The probability of recall was significantly greater for those facts for which adequate elaborations were generated

as compared to those with inadequate explanations [$t(36)=9.11$, $p<.01$]. When the adequate answers were further analyzed, correct elaborations promoted greater retention than either inaccurate elaborations [$t(36)=7.13$, $p<.01$] or inadequate responses [$t(36)=6.88$, $p<.01$].

Elaborative-interrogation-plus-cooperative-learning condition

There was a significantly greater probability of recall for facts associated with adequate elaborations than for those with supporting responses [$t(27)=5.16$, $p<.01$], no responses [$t(26)=3.77$, $p<.01$], or inadequate responses [$t(29)=3.08$, $p<.05$]. The only other significant difference favoured accurate elaborations over supporting elaborations [$t(27)=3.54$, $p<.05$].

60-Day Matched Association

Elaborative-interrogation condition.

Facts that were associated with adequate elaborations were retained better than those with inadequate explanations [$t(36)=10.39$, $p<.01$]. As in the other three memory tests, items with correct elaborations had a greater probability of subsequent recall than did those with inaccurate elaborations [$t(36)=8.75$, $p<.01$] or with inadequate answers [$t(36)=8.13$, $p<.01$].

Elaborative-interrogation-plus-cooperative-learning condition.

As in the other three dependent measures, generation of adequate elaboratives promoted subsequent recall relative to supporting responses [$t(27)=5.76$, $p<.01$], no responses [$t(26)=4.53$, $p<.01$], or inadequate responses [$t(29)=2.86$, $p<.05$]. Facts with scientifically correct elaborations and with inadequate explanations promoted better recall relative to facts with supporting elaborations [$t(27)=3.71$, $p<.05$; $t(28)=3.45$, $p<.05$, respectively]. There were no other significant differences [$t(28)\leq 3.14$, $p>.05$].

Student Errors

In general, students made relatively few errors when recalling targetted facts about the animals. The means and standard deviations for intrusion errors, irrelevant statements, and incorrect statements are listed in Table 4 as a function of participation in experimental and control conditions.

Intrusions

Results of the independent ANOVA indicated that students did not differ in the generation of intrusion errors across the four study conditions [$F(3,64)=1.71$, $p>.05$].

Table 4

Means, Medians, and Standard Deviations for Intrusion Errors, Irrelevant Statements, and Incorrect Statements as a Function of Condition

Condition	<u>M</u>	Median	<u>SD</u>
Intrusion Errors			
Elaborative-interrogation-plus-cooperative-learning	0.88	0.5	1.15
Cooperative-learning	1.81	1.5	1.72
Elaborative-interrogation	1.53	1.0	1.81
Reading-control	2.29	1.0	2.24
Irrelevant Statements			
Elaborative-interrogation-plus-cooperative-learning	1.75	1.5	2.21
Cooperative-learning	2.00	1.5	2.28
Elaborative-interrogation	1.21	1.0	1.47
Reading-control	0.35	0.0	0.65
Incorrect Statements			
Elaborative-interrogation-plus-cooperative-learning	1.50	1.0	2.21
Cooperative-learning	1.06	1.0	1.06
Elaborative-interrogation	0.63	0.0	1.07
Reading-control	0.53	0.0	0.72

Note. n= 16, 16, 19, 17 respectively for conditions.

Irrelevant Statements

Results of the independent ANOVA revealed that there was a significant effect of condition [$F(3,64)=2.88$, $p<.05$]. Post hoc comparisons showed that students in the cooperative-learning condition recalled more facts that were correct but not part of the target information than did students in the reading-control condition ($q=3.83$, $p<.05$). There were no other significant differences ($q \leq 3.20$, $p>.05$).

Incorrect Statements

There was a significant effect of condition [$F(3,64)=2.94$, $p<.05$]. Post hoc comparisons revealed that more incorrect statements were made by students in the elaborative-interrogation-plus-cooperative-learning condition than were made by students in the elaborative-interrogation condition ($q=3.43$, $p<.05$). The occurrence of errors between students in the elaborative-interrogation-plus-cooperative-learning condition and the reading-control condition approached significance ($q=3.67$, critical $q=3.73$, $p>.05$), with students in the elaborative-interrogation-plus-cooperative-learning condition generating more incorrect statements than students in the control condition. The differences between all other conditions were not significant ($q \leq 2.00$, $p>.05$).

Questionnaire Responses

There were no significant effects for study condition on self-evaluations of performances or on perception of task difficulty indicated by any of the separate ANOVAs [smallest $F(3,64)=.412$, $p>.05$]. However, the result for Question Seven which asked students to indicate their willingness to participate in future studies approached significance [$F(3,64)=2.56$, $p=.063$]. Further analysis revealed a descriptive trend favouring subjects in the elaborative-interrogation-plus-cooperative-learning condition when compared to subjects in the reading-control condition ($q=3.59$, critical $q=3.73$, $p>.05$).

Summary of Quantitative Results

For all four dependent measures, subjects in the elaborative-interrogation condition had superior retention relative to students in the reading-control condition. For free recall, immediate matched association, and 30-day matched association, learning was greater for subjects in the elaborative-interrogation-plus-cooperative-learning condition than for reading-control subjects. For free recall and immediate matched association, results of students involved in cooperative learning were higher than for those who read the material.

For subjects in the elaborative-interrogation condition, the generation of adequate answers was associated

with greater retention than was the generation of inadequate responses across all four memory tests. Items answered with scientifically correct elaborations were retained better than were those items that were answered inadequately or elaborated on incorrectly.

In the elaborative-interrogation-plus-cooperative-learning condition, the generation of adequate answers was associated with superior retention than were response failures or the generation of supporting elaborations or inadequate responses across all four memory tests. Items answered with scientifically correct elaborations were retained better than were those items associated with supporting elaborations across all four dependent measures. Facts for which inadequate answers were provided were associated with greater recall on the 60-day matched association test than were those facts for which supporting elaborations were given.

Overall, few errors were made during free recall. There were no differences between conditions for intrusion errors. Subjects in the cooperative-learning condition made more irrelevant statements during recall than did subjects in the reading-control condition. More incorrect statements were made by subjects in the elaborative-interrogation-plus-cooperative-learning condition relative to control subjects.

There were no significant differences due to study condition for any of the questionnaire responses. For

Question Seven, there was a descriptive difference indicating that elaborative-interrogation-plus-cooperative-learning students would be more willing to participate in similar studies in the future than would control students.

CHAPTER FIVE: DISCUSSION

Summary

There have been exciting and often controversial trends in education over the past 25 years. Past studies spanning the last two decades have indicated that "cooperative learning is appropriate for a broad range of learning objectives: the 'basic skills' as well as the more complex cognitive and social goals of schooling" (Joyce & Weil, 1986, p. 217). Recent research has also demonstrated the effectiveness of a question-answering strategy called elaborative interrogation in promoting learning of declarative knowledge.

This study examined whether the use of elaborative interrogation in a cooperative-learning setting facilitated the learning of facts about familiar animals more so than either individual use of the strategy or collaborative study. The results of all three experimental groups were also compared to those of a reading-control group. Prior to testing, students in all four conditions were given training and practice in cooperative-learning activities in order to ensure that collaborative skills were in place. Retention was assessed via one measure of immediate free recall and three measures of associative matching (immediate, 30-day, and 60-day). Whether the quality of the elaborative-interrogation response affected the probability of retention

was also investigated.

Conclusions and Implications

Elaborative Interrogation and Cooperative Learning

Superior short-term and long-term retention was attained by students in the elaborative-interrogation condition relative to those in the reading-control condition. This finding confirms previous studies that the use of this question-answering strategy promotes learning of factual material more so than the more traditional approach of repetitive reading. When searching for answers to the why questions, students process new facts deeply and begin to establish links between their prior knowledge and the new information. Through this process, the to-be-learned material becomes more meaningful, thus facilitating subsequent recall.

Students in this study and in others found it relatively easy to generate explanations to the why questions. Educators seeking an effective strategy that requires minimal instruction should encourage students to use this technique when learning new information in order to help them acquire background knowledge, a factor that is essential for active, constructive learning. One area for future research would be to determine if students can be taught to use elaborative-interrogation in a self-regulated

manner which would enable them to become more independent and efficient learners.

Students' performances in the elaborative-interrogation-plus-cooperative-learning condition were significantly greater than those of students in the reading-control condition on the free recall, immediate matched association, and 30-day matched association measures but only descriptively better on the 60-day matched association measure. As in the elaborative-interrogation condition, learning is facilitated when individuals seek to connect new facts with prior knowledge while attempting to generate elaborations. By sharing information, members are exposed to other people's background knowledge. In a group learning situation, incorporation of a strategy gives structure to the required task (Watson, 1991) and provides members with an effective technique with which to process new information.

Students in the cooperative-learning condition did achieve greater scores on the two tests that measured immediate recall and recognition relative to the control students. This finding is consistent with active, constructive learning theories which state that students' attention is heightened and understanding is facilitated through discussion as members form interconnections between past knowledge and new information (Harris & Pressley, 1991; Paris & Winograd, 1990). Learning is also promoted for all

members with various states of expertise through exposure to the prior knowledge of other members.

There were no significant differences between the cooperative-learning and the reading-control conditions for the 30-day and 60-day recognition measures. The fact that only a half-hour session was devoted to cooperative study of the material may explain why these results are not as high as predicted from previous research. Moreover, cooperative-learning experiments in the past have often failed to measure long-term retention. Researchers interested in further investigation of the effects of cooperative learning on acquisition of facts may wish to include long-term memory measures in their designs.

There were no significant differences in students' scores across the experimental conditions. Elaborative-interrogation-plus-cooperative-learning did not prove to be more powerful than either approach alone. Stevens et al. (1991) had found that students who received direct instruction on reading strategies in a cooperative setting achieved descriptively higher scores on posttest measures than did those who received strategy instruction on an individual basis. One reason for the discrepancy between past findings and this study may be that in the previous study, direct strategy instruction plus cooperative training occurred over a four-week period and incorporated more feedback and practice than did this study. This possibility

could be investigated by designing more long-term studies which should provide more opportunities for students to reflect on the use of the strategy and their cooperative skills.

Both generation of elaborations and sharing of ideas through discussion are powerful strategies that encourage students to focus on new material and to process the facts more deeply and memorably. In this experiment, individual use of the elaborative-interrogation strategy promoted the most durable learning gains relative to the reading-control condition. Presumably, individuals in the elaborative-interrogation condition processed every fact deeply when asked to explain why each fact was true, whereas students in the elaborative-interrogation-plus-cooperative-learning and in the cooperative-learning condition may have occasionally relied on other members to share background information and supply a response. Thus, for these students, not every fact may have been made personally relevant, and hence memorable, to the same extent as for those students in the elaborative-interrogation condition. In a more naturalistic setting, students could be provided with teacher guidance and additional practice to further enhance the effectiveness of both cooperative learning and elaborative interrogation plus cooperative learning.

The results of this study are consistent with previous research findings in that elaborative interrogation

facilitated learning relative to repetitive reading. For three of the four memory tests, the use of this elaborative strategy in a collaborative fashion was more potent than repetitive reading. Cooperative learning promoted greater immediate recall and retention relative to the reading-control condition. These are important findings given that control subjects were required to process the information for the entire study time, a method traditionally employed when students are required to learn new material. Concern that directing students' attention during study to information not specified in the passages might result in more errors during recall (Woloshyn et al., 1990) was generally unfounded as errors were rare.

Effort was made by the researcher to ensure that the findings of this study would be generalizable to regular classroom use. A heterogeneous mix of students, including special education and English as a second language individuals, were included. The students studied target information and were tested under a variety of conditions including hallways, spare portables and classrooms, corners of noisy classrooms, and in the health room. The use of animal facts was in keeping with typical classroom content. In the future, however, designing a study where students were not required to pause and elaborate between every sentence would be provide an even more ecologically valid study.

Somewhat surprisingly, the scores of the reading-control subjects for the 30-day and 60-day immediate matching tests did not drop as dramatically as expected. One possible explanation would be that since the interrelated facts about each animal were arranged in paragraphs, more automatic elaborations may have been stimulated (Wood et al., 1990) or more meaningful associations may have been made than if isolated facts were presented ("man" statements). Another possible explanation could be that since students were given more time (35 seconds) to process the new material than were subjects in previous studies involving children (15 seconds, Wood et al., 1990; Woloshyn, Paivio, & Pressley, in press) other strategies such as imagery may have been spontaneously employed. A third possible reason why control students' scores did not drop dramatically may be that when students discussed their experiences after the initial testing session, various answers were shared. Since scores of students in all three experimental conditions were significantly higher, students in the control condition may have overheard the correct answers during the intervals between testing.

This study did not evaluate the impact of cooperative learning on social and emotional development. However, informal observations by the researcher and teacher evaluations revealed that the interpersonal skills of

students involved in this study and the class cohesiveness improved throughout the year. The four teachers continued to involve their students in cooperative endeavours throughout the year. Given the evidence found in the literature, future investigators may wish to include pre-test and post-test measures assessing the affective gains of cooperative versus individualistic learning environments.

Elaborative Responses and Probability of Recall

The data from this study supported previous research findings that even when students are unable to generate a response to the why questions, learning is facilitated relative to reading for understanding (Pressley et al., 1990; Woloshyn et al., 1990). While searching for an answer, it is likely that students' task attention and effort are heightened with increased effort being placed on processing target information (Woloshyn, Paivio, & Pressley, in press).

The findings from this study indicate that generation of adequate elaborations consistently promoted learning relative to production of inadequate explanations on all four memory tests for students in both the elaborative-interrogation and the elaborative-interrogation-plus-cooperative learning conditions. Previous studies (Woloshyn et al., 1990; Woloshyn, Paivio, & Pressley, in press; Wood et al., 1990) have not found as strong a relationship

between adequacy of response and probability of subsequent recall.

As in Wood et al.'s (1990) study, items answered with scientifically correct elaborations were retained better than those facts with inaccurate elaborations. Presumably, stronger links were made to existing schemata when students possessed relevant and accurate prior knowledge. This study also found that generation of correct elaborations was more potent than provision of supporting elaborations (providing additional yet confirming information to an adequate explanation in the elaborative-interrogation-plus-cooperative-learning condition). It is possible that those students who generated correct elaborations engaged in a more active search for relevant background information than did those students who gave supporting responses. Another possibility is that students may have sometimes provided supporting elaborations for adequate but inaccurate responses. Due to the experimental nature of this study, the researcher was unable to encourage participants to challenge students' incorrect explanations ("The blue whale lives in the Arctic and Antarctic oceans because it's cold-blooded"). In a more naturalistic setting, teachers would be able to facilitate the discussions and guide members towards generation of more plausible and accurate explanations.

In this study, the only comparison between conditional

probabilities associated with adequate responses and failures to respond was from the elaborative-interrogation-plus-cooperative-learning condition. Generation of an adequate explanation was associated with greater recall relative to failure to generate a response. This finding is inconsistent with an adult elaborative-interrogation study (Woloshyn et al., 1990). However, in a study with younger subjects (Grade Six and Grade Seven students) Woloshyn, Paivio, and Pressley (in press) found that on 2 of the 10 measures, items associated with adequate responses were retained better than were those items associated with response failures. The finding from the present study is consistent with a similar study involving children who studied animal facts (Wood et al., 1990).

None of the previous studies investigated elaborative interrogation in a group setting. In the present study, one possible reason why generation of adequate responses was associated with greater recall relative to response failures may be that not every group member of the elaborative-interrogation-plus-cooperative-learning condition was as actively involved in the search for why-question explanations as they may have been if they were on their own. However, because of the group dynamics involved in this study, it is difficult to determine whether students who failed to respond did not possess relevant prior knowledge, did not get an opportunity to voice their

opinion, were reluctant to volunteer their response in front of their peers, or heard their explanation expressed by a teammate. Slavin (1987a) cites research demonstrating that in cooperative interactions, the students who learn the most are those who produce and receive elaborated explanations during group discussions.

This study did not attempt to discover whether or not the quality of response generated by a teammate affected the probability of recall for other members of the group. However, since learning was facilitated for those students in the elaborative-interrogation-plus-cooperative-learning condition relative to those students in the reading-control condition, it is likely that students who were somewhat deficient in prior knowledge benefitted from the exposure to new ideas. This is an assumption that warrants further investigation, especially as groups of students are often asked to study material for which they possess heterogeneous background knowledge.

Recommendations

Successful participation in an informational society requires the collaboration of individuals who possess a wide range of knowledge and abilities, along with sound communication and social skills. Educators should be encouraged to implement cooperative-learning and elaborative-interrogation procedures which have been shown

by the findings of this study and other research to yield positive benefits for students. Since forced change often leads to resentment and resistance, a collaborative approach towards the implementation of these techniques should be used. Superintendents, consultants, resource and support personnel, principals teachers, parents, and students should all be involved in the planning and delivery processes. Professional readings, workshops, conferences, in-services, meetings, discussions, coaching and modelling are some of the ways to first establish the credibility of the new methodology and then to begin implementation. Traditional teachers still caught in the transmission mode of education should be given considerable encouragement and support to adopt a more active, holistic stance towards teaching and learning.

One effective technique that is relatively easy to implement is elaborative interrogation. When presenting students with new material for which they possess relevant prior knowledge, classroom teachers could easily demonstrate this question-answering strategy to the whole class, small groups, or individuals. Appropriate modelling and feedback should be provided.

The implementation of cooperative learning requires more patience, time, and teacher expertise. Experienced and knowledgeable educators should reassure skeptical colleagues that this teaching approach promotes affective, cognitive,

and social development. Establishing a warm learning environment and the teaching of interpersonal and communication skills are the first steps towards implementation. For the most efficient use of classroom time, these small-group skills should be taught and practised in conjunction with academic tasks. Teachers should also become familiar with the basic elements of some of the cooperative-learning models (Group Investigation, Co-Op Co-Op, Jigsaw, Student Team Learning, Circles of Learning) and then select those that are compatible with their teaching style and learning objectives.

Adopting a cooperative-learning approach requires a teacher to assume a more facilitative role. However, an effective teacher recognizes that there are instances where direct instruction is necessary. As well as teaching the social and affective skills, educators must also help students build a repertoire of cognitive strategies that will promote their critical thinking and "cultural literacy". The use of elaborative interrogation in a cooperative setting is an efficient way of meeting this challenge. Students with varying degrees of background knowledge could be paired or teamed together to maximize the generation of adequate elaborations and to coach each other on the appropriate use of this strategy. Teachers should facilitate the discussions encouraging students to challenge inaccurate statements and guiding them towards reaching a

consensus on the most logical explanations. Time for reflection should be provided so that participants are able to evaluate how well they are achieving their goals.

Further research is needed to determine whether the greatest benefits result where these two approaches are used in combination versus either approach on its own. These studies should be designed to measure long-term retention and should incorporate pre-and post-test measures to determine affective and social gains. Since an educational goal is to develop independent learners, studies are also needed to determine if students could be trained to use the elaborative-interrogation strategy in a self-regulated fashion, especially with factually dense material.

General Conclusions

Fact acquisition is an important component of learning. Students must possess sufficient prior knowledge in order to make sense of new information they encounter, thus enabling them to actively and meaningfully construct new knowledge. The data of this study confirm previous research findings that both elaborative-interrogation and cooperative-learning are powerful procedures for enhancing learning of factual material. In today's busy classrooms where teachers are seeking efficient ways to meet the social, emotional, and cognitive needs of a variety of students, the integration of both elaborative-interrogation and cooperative-learning

procedures merits serious consideration.

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Appendix A

Letter of Consent

Dear Parent(s),

In the near future, a study will be conducted at Thorn Lodge Public School and Homelands Senior Public School investigating whether students' learning of science facts can be improved following instructions to use a question-answering learning strategy while working in cooperative groups. Basically, the question-answering strategy requires that students attempt to answer why presented facts are true. The purpose of this letter is to request your permission for your child's participation in the project. This project is for my thesis in completion of a Master of Education program at Brock University.

Each child will be seen by me for approximately one hour. I have been teaching for 22 years, the last 18 of which with the Peel Board of Education, and have experience with grade 6 students. The students will be seen individually or in groups of four and asked to study 6 brief animal stories, each containing 6 facts. Different groups will be given different study instructions. Some students will be asked to attempt to answer why these facts are true (e.g., "Why do you think the house mouse is often found where people live?"). Some will be asked to study the information cooperatively with members of their group. Others will be asked to reread the stories. These sessions will be audio taped for later analysis. As a follow-up, students will be asked to independently complete some short quizzes and a brief questionnaire.

In the past, both children's and adult's learning of factual information has been improved following instructions to answer why the presented facts are true. Research has shown that cooperative learning has beneficial effects not only on achievement but also on self-esteem and social skills. I am interested in confirming whether this question-answering approach in combination with cooperative group-work will further enhance learning.

In general, children enjoy participating in these types of sessions. However, if for any reason a child indicates that s/he does not wish to continue, the student will be removed from the study immediately. All of the data from this study will be stored anonymously in order to protect the privacy of students. The audio recordings of the study sessions will be destroyed after students' responses have been analyzed. Although group averages may be reported, the performances of individual children will never be discussed.

Please return the attached consent form to your child's school as soon as possible indicating whether you give your permission or not. Please note that it is important that you return the form in either case. Thank you for taking the time to read this letter and for sending the permission

form back to the school. If you have any questions or concerns about this study, please feel free to call the school and leave a message for me to contact you.

Sincerely,

Barbara Kahl

Consent Form

I have read the letter of explanation describing the study regarding the use of the question-answering learning strategy and cooperative learning for children's acquisition of science facts. I have been informed that with my permission, my child may be asked to attempt to answer why several animal facts are true. I understand that my child may be working independently or may be working cooperatively with the three other group members. I understand that all participants will be asked to individually complete some brief quizzes and a short questionnaire.

I have been informed that my child's participation in this study is entirely voluntary. All information will be kept confidential so that any report(s) of the results will not be associated with my name or my child's name. I have also been informed that I may withdraw my child from the study at any time and that I may have my child skip any question(s) or portion(s) of the study that I wish.

I AGREE to have my child participate in the study.

Parent's signature _____

Date _____

Student's signature (Optional) _____

I DO NOT AGREE to have my child participate in the study.

Parent's signature _____

Date _____

Student's signature (Optional) _____

I wish to receive a summary of the study. Yes__ No__

Animal Stories

The House Mouse

The house mouse likes to live in warm, dry areas. It is most often found anywhere people live. The house mouse lives in southern Canada. It eats nuts, vegetables, fruits, and grains. When it is tired, the house mouse heads for its home which is usually a tiny hole or dark corner. There are many dangers for the house mouse like owls, hawks, and snakes.

The Townsend Mole

The townsend mole lives in tunnels. It especially likes to live in warm, humid areas. Usually the mole prefers the Pacific coast. The townsend mole eats insects and grubs. The townsend mole naps throughout the day. There are few dangers for the mole except for snakes.

The Emperor Penguin

The emperor penguin lives only in Antarctica. It likes to live in the sea for a few weeks at a time. The emperor penguin never makes a nest or home to hide in. The emperor penguin eats squid and fish. Although Antarctica is cold all of the time, the emperor penguin sleeps longer when it gets really cold. One real danger for the emperor penguin is the leopard seal.

The Little Brown Bat

The little brown bat lives in dark places like caves, attics, or abandoned houses. The little brown bat lives with a few to several hundred other bats. The little brown bat lives in eastern Canada. Its favourite food is flying insects. The bat sleeps all winter. There are very few dangers for the little brown bat except for the weather.

The Blue Whale

The blue whale lives in the Arctic and Antarctic oceans. Most of the time the blue whale prefers to be near the surface of the water. The blue whale only eats for about three months of the year. When it does eat, it likes ocean plants and small shrimp-like creatures. The blue whale sleeps by taking short naps. The worst danger for the blue whale is being caught under the ice.

The western spotted skunk lives in a hole in the ground. Often the skunk lives alone, but families of skunks sometimes stay together. The skunk's hole is usually found on a sandy piece of farmland near crops. The skunk mostly eats corn. It sleeps just about anytime except between three o'clock in the morning and sunrise. The biggest danger to this skunk is the great horned owl.

The American Pika

The american pika lives so high up in the rocky mountains that trees can't grow. The pika likes to live in and around rock piles. The pika is only found in British Columbia. It eats grasses and flowering plants. The pika sleeps during the night. The most dangerous animals for the american pika are birds and weasels.

Appendix C

Free Recall Quiz

Under each heading, write down as much information as you can remember about the animal you studied. Remember that you learned 6 facts for each animal. Please use point form. You will have as much time as you like to complete this quiz.

The Townsend Mole

The Little Brown Bat

The Western Spotted Skunk

The Emperor Penguin

The Blue Whale

The American Pika

Matched Association Quiz

Fill in each blank with the letter for each animal that correctly matches each statement. Remember that you learned 6 facts for each of the 6 animals. Choose from the following list:

- A---The Townsend Mole
- B---The Emperor Penguin
- C---The Little Brown Bat
- D---The Blue Whale
- E---The Western Spotted Skunk
- F---The American Pika

- ___ lives in Eastern Canada
- ___ usually prefers to be near the surface of the water
- ___ lives in tunnels
- ___ is only found in British Columbia
- ___ eats fish and squid
- ___ its hole is usually found on a sandy piece of farmland near crops
- ___ flying insects are its favourite food
- ___ lives in a hole in the ground
- ___ usually prefers the Pacific coast
- ___ eats for only about 3 months of the year
- ___ lives high up in the rocky mountains where trees can't grow
- ___ lives in the sea for a few weeks at a time

- ___ eats insects and grubs
- ___ lives in dark places like caves, attics, or abandoned houses
- ___ sleeps during the night
- ___ mostly eats corn
- ___ sleeps by taking short naps
- ___ lives in warm, humid areas
- ___ its main enemy is the great horned owl
- ___ eats ocean plants and small, shrimp-like creatures
- ___ sleeps all winter
- ___ lives only in Antarctica
- ___ lives in and around rock piles
- ___ sleeps just about anytime except between 3 AM. and sunrise
- ___ its worst danger is being trapped under the ice
- ___ eats grasses and flowering plants
- ___ often lives alone, but sometimes stays with families of its own kind
- ___ lives with a few to several hundred others of its kind
- ___ never makes a nest or a home to hide in
- ___ naps throughout the day
- ___ has very few dangers except for the weather
- ___ birds and weasels are its main enemies
- ___ the leopard seal is its one enemy
- ___ lives in the Arctic and Antarctic oceans
- ___ has few enemies except for the snake
- ___ sleeps longer when it gets really cold

Appendix E

Questionnaire

Please rate each of the following statements from 1 (not very) to 5 (a great deal/very). Fill the blank at the end of each question with one number to show your opinion.

Please answer all questions from 1 to 7 and any of the other questions that apply to you. Skip only those questions that don't fit your situation.

1. How difficult were the animal stories to read? _____
2. How difficult were the animal stories to understand? _____
3. How difficult was it for you to complete the free recall quiz? _____
4. How well do you think you did on the free recall quiz? _____
5. How difficult was it for you to complete the matching quiz? _____
6. How well do you think you did on the matching test? _____
7. How willing would you be to participate in more studies like this one? _____

Questions 8 and 9 should be answered ONLY if you worked in a group.

8. How difficult did you find it to work in a group? _____
9. Did you find that working with a group helped you remember the facts better? _____

Questions 10 and 11 should be answered ONLY if you answered "why" questions. You may have done this on your own or with a group.

10. How difficult did you find it to answer the "why" questions about the animals? _____
11. Did you find that answering the "why" questions helped you remember the facts better? _____

Questions 12 and 13 should be answered ONLY if you worked by yourself and were asked only to read the stories and try to remember the details. You did NOT have to answer "why" questions.

12. How difficult did you find it to read the stories over again by yourself as you studied the facts? _____
13. Did you find that reading the stories over again helped you remember the facts better? _____

Please feel free to use this space at the bottom of the page to write down any thoughts or feelings you have about taking part in the whole experience. You may use the back of the page too.
